



REVIEW ARTICLE

Physician-performed Focused Ultrasound: An Update on Its Role and Performance



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Received 13 February 2015; accepted 25 February 2015
Available online 27 March 2015

KEYWORDS

focused ultrasound,
performance,
physician,
surgeon

There is an increase in the use of focused ultrasound (US) by physicians because it offers the major benefit of reduction in time to diagnosis. Some of these physicians have received formal training on focused US, others have not received any such training. However, among the formal training given on focused US, there is inconsistency across the teaching protocols. This review presents performances of focused US commonly performed by physicians, compared with radiology US. The various teaching protocols are also discussed.

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Introduction

Nowadays, ultrasound (US) is widely used mainly because of the many advantages it offers, such as its portability and the absence of ionizing radiation. It is not only used in radiology departments but also in critical care or emergency departments by medical nonradiologists. For example, surgeons have performed the focused assessment with sonography for trauma (FAST) technique in patients

with trauma. The utilization of US by medical non-radiologists has expanded to a variety of clinical settings. Most of them are for specific purposes, called focused US, targeted US, or point-of-care US, unlike radiology US, which is a complete examination. This is the reason US is increasingly being incorporated into the curriculum of medical schools [1,2]. Although US is a part of the educational curriculum, the protocol for US education has been inconsistent among medical schools. A prospective study in 2007 revealed that residents who received an introductory US course and proctored US training had a significant improvement in knowledge 6 months after the introductory training course [3]. It has been accepted that US is a highly operator-dependent technique. Although many institutions have published their guidelines for physicians to perform US in various clinical settings [4,5], most were made by consensus, and not based on scientific studies.

Conflicts of interest: The authors have no conflicts of interest to disclose.

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Here we review various scientific studies of US commonly performed by medical nonradiologists as well as its performance. We hope that the data presented herein may provide guidance in establishing a training protocol for physicians for each specific purpose.

Focused assessment with sonography for trauma

FAST is the most common US study performed by emergency physicians (EPs) [6]. Because it offers rapid evaluation of trauma patients, it is now included in undergraduate education in many countries [1]. In 1996, Ali et al [7] reported that a focused trauma US workshop significantly increased the ability of general surgeon residents and attending staff to identify intraperitoneal fluid.

This workshop included lectures and hands-on teaching of the skills using live patient models. FAST performed by EPs yielded the following results: sensitivity, 86%; specificity, 99%; positive predictive value (PPV), 97%; negative predictive value (NPV), 98%; and accuracy, 97% [8]. A prospective study [9] compared the accuracy in diagnosing abdominal free fluid using US between EPs and radiologists. In that study, the specificity of ultrasonographic diagnosis was found to be comparable between the two groups. A recent systematic review recommended that a FAST course should be at least 16 hours of duration, including the following: 4 hours of theory, 4 hours of training on normal human models, and 8 hours of learning using animal models, case scenarios by video clips, or simulators [10].

Pneumothorax

Lung US has been included in the FAST courses, named as the *extended FAST*, since 2004 [11]. Using computed tomography (CT) and thoracotomy tube placement as the gold standard, lung US study for the detection of pneumothorax performed by staff radiologists had a sensitivity of 77%, a specificity of 99.8%, a PPV of 98.5%, an NPV of 97%, and an accuracy of 97.2% [12]. Similar accuracy was achieved for all these measures by EPs performing lung US (sensitivity 86.2%, specificity 97.2%, PPV 89.3%, NPV 96.3%, and accuracy 94.8%) [13]. The sensitivity of lung US was much higher than chest radiograph, and the agreement in determining the size of pneumothorax between US and CT was very high [13]. In addition, US reduced the time for the diagnosis of pneumothorax as compared with chest radiograph [13].

Biliary disease

An US study of the right upper quadrant (RUQ) of the abdomen has been increasingly performed by EPs. Among five urgent US targets (FAST, pleura, bladder, abdominal aorta, and gallbladder), gallbladder US is the most difficult to perform [14]. Previous studies have shown that emergency department bedside ultrasonography (EUS) performed by EPs had a good agreement with the radiologists in detecting cholelithiasis; however, the EPs in these studies had varying degrees of experience [15,16]. A pilot

study by Jang et al [17] assessed resident-performed US of the RUQ and concluded that 10 US examinations as a minimum standard for the training or credentialing of EPs performing RUQ US examinations are not sufficient. Gaspari et al [18] reported that 25 US examinations of the gallbladder were sufficient for evaluating clinicians' competency. However, a prospective study from the United States evaluated 1837 US examinations performed by residents who had completed an introductory course on EUS. They found that increasing number of examinations (up to 50) only had a little effect on the accuracy of the diagnosis of cholelithiasis and cholecystitis by EUS [19]. These authors later reported the same accuracy in performing EUS between participants who completed a 2-week, EUS elective course with 100 EUS examinations and those without the EUS course who performed the same number of examinations over a longer period [20].

Renal ultrasound

Although CT is the gold standard for detection of urolithiasis [21], renal US is still widely used. A recent study evaluated bedside renal US performed by EPs and reported a 76% sensitivity to detect hydronephrosis and a 90% sensitivity for large stones (>4 mm) [22]. All the EPs in this study were credentialed for renal US and had experience of at least 25 prior renal US examinations [22]. By contrast, Caronia et al [23] reported that the sensitivity and specificity of US for the detection of hydronephrosis performed by internal medicine residents who had no US experience were 94% and 93%, respectively, after only a 5-hour training module.

Abdominal aortic aneurysm

The aorta is one of three easiest US targets (bladder, aorta, and pleura) to examine [14]. In addition, aortic US is the fastest investigation to perform [14]. A pilot study investigated primary-care residents (PCRs) who performed US screening for abdominal aortic aneurysm, and showed that PCRs with no US experience who after receiving little formal US training were able to rapidly learn the technique of US imaging of the aorta with only five to 10 patient examinations [24].

Acute appendicitis

US for the diagnosis of acute appendicitis (AA) is still commonly used, although CT has a higher diagnostic accuracy [25,26]. It has been proven that joint evaluation of the results from clinical evaluation and US improved diagnostic accuracy [27]. In addition, a diagnostic pathway using routine US, limited CT, and clinical re-evaluation of patients suspected to be having AA can provide excellent results [28]. However, the operator dependence is the issue of concern in this regard. A retrospective study in 1998 compared the diagnostic accuracy of appendiceal US performed between unsupervised technicians and supervised technicians, and found a significant lower sensitivity for US performed by unsupervised technicians [29]. This result is supported by another study that demonstrated that

pediatric sonographers identified the appendix better than nonpediatric sonographers [30]. Surgeon-performed US for the diagnosis of AA has been increasingly used but with a wide range of reported accuracy [31,32]. According to a systematic review, US diagnosis of AA performed by surgeons has a pool sensitivity of 92% and a pool specificity of 96% [33]. Another study compared the accuracy of appendiceal US performed by surgical residents who participated in a 3-day introductory abdominal US course with that of radiologists. The results showed comparable accuracy between the two groups [34]. This may be because radiologists commonly pay limited attention to clinical and laboratory information than US findings when interpreting radiology US, whereas surgeons compare US findings with the clinical information obtained.

Deep vein thrombosis

Doppler US has now replaced contrast venography for the diagnosis of deep vein thrombosis (DVT) with a sensitivity of 96% and specificity of 98% [35]. Caronia and colleagues [36] found a time delay of 14.7 hours between the order of a comprehensive US for DVT and the interpretation of its results by a radiologist. In their study, residents trained in a standard 2-hour course for DVT performed two-point compression US for the diagnosis of DVT and showed a sensitivity of 100% and a specificity of 97% at the common femoral vein, with a slightly lower sensitivity for the popliteal vein [36].

Intussusception

US is the first imaging modality for the diagnosis of pediatric intussusception [37]. Riera et al [38] reported that pediatric EPs who had performed 100–150 US examinations with no experience in bowel US received 1-hour focused training of intussusception US and were able to accurately diagnose pediatric ileocolic intussusception.

Hypertrophic pyloric stenosis

A small case series in 2009 demonstrated a high diagnostic performance of EP-performed US for the diagnosis of hypertrophic pyloric stenosis [39]. Another study showed that a surgeon with five proctored examinations had a high diagnostic accuracy [40]. In addition, a recent prospective article evaluated pediatric EPs-performed US, and reported a sensitivity of 100% and a specificity of 100% [41].

Conclusion

Physician-performed US for specific purpose has become a part of the physical examination. It has been increasingly and rapidly expanded to various clinical settings. This literature review revealed a wide variety of US training protocols and their diagnostic performances. It should be noted that the results of US depend on three factors, namely, the operator's experience, the quality and technology of the US machine, and the patient population. In addition, sonographic learning skills and confidence vary

greatly among trainees. Recommendations for initial training to improve diagnostic capability should include didactic lecture, hands-on training on live models, and proctored scans on positive patients. The time required and the number of proctored scans to achieve sufficient ability may vary depending on the difficulty level of the US targets as well as sonographic learning skills and confidence of the operators.

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